

NEW MEASUREMENT OF THE SINGLE DIFFRACTION DISSOCIATION AND THE NATURE OF THE POMERON

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Abstract

Recent data on single diffraction dissotiation, measured by CDF at the Tevatron show a moderate increase with energy of the cross section, thus confirming the predictions based on the dipole pomeron model.

1.Introduction

Recently new results on single diffraction dissociation from the Tevatron at $\sqrt{s} = 546$ (1800) GeV have been published by the CDF [1]. The measured integrated cross section

$$\sigma_{SD} = 7.89 \pm 0.33 \text{ (} 9.46 \pm 0.44 \text{) } mb,$$

was found to be much below the value expected from extrapolations based on the popular supercritical pomeron model.

In this connection we find it appropriate to recall the results of our earlier investigations based on the dipole pomeron model [2]. In that paper, we have used a unitarized (so-called u -matrix) representation for the scattering amplitude of the form

$$T(\rho, s) = \frac{u(\rho, s)}{1 - iu(\rho, s)}, \quad (1)$$

where ρ is the impact parameter.

The u -matrix was choosen in the form

$$u(\rho, s) = ig(s) \exp \left(- \frac{\rho^2}{4\alpha'(b + L)} \right), \quad (2)$$

coresponding to a dipole Pomeron in the impact parameter representation [2] ($L = \ln(s/s_0)$, and b, s_0 are adjustable parameters). From eqs. (1) and (2) one obtains [2] for the total and integrated elastic scattering cross sections:

$$\sigma_t = 16\pi\alpha'(b + L) \ln(1 + g), \quad (3)$$

$$\sigma_{el} = 16\pi\alpha'(b+L)\left[\ln(1+g) - \frac{g}{1+g}\right], \quad (4)$$

$$\sigma_{in} = 16\pi\alpha'(b+L)\frac{g}{1-g}. \quad (5)$$

The rise with the energy of the ratio σ_{el}/σ_{tot} has motivated the choice of $g = g(s)$ in the form

$$g(s) = g_0(s/s_0)^\epsilon,$$

where $\epsilon = 0.06$. It corresponds to a double Regge (Pomeron) pole with the intercept $1 + \epsilon$. In this model, the total cross sections at asymptotic energies saturate the Froisart bound, $\ln^2(s)$, but at present accelerator energies the rate of increase is between $\ln(s)$ and $\ln^2(s)$, yielding $\sigma_{tot} = 74.8 \text{ mb}$ at $\sqrt{s} = 1.8 \text{ TeV}$.

Earlier, in Ref.[3], we have suggested a model for diffraction dissociation based on the dipole pomeron. The basic idea [4] behind that model was that the function $g(s)$ in the u -matrix (2) is proportional to the product of the quark number in hadrons A and B ,

$$g(s) \sim n_A n_b.$$

In single diffraction, only quarks q from one hadron should be counted, consequently $\sigma_{SD} \sim \sqrt{g}$. (Since diffraction dissociation makes only a fraction of the multiple production, this will be taken into account by an adjustable parameter, to be denoted by c .)

It follows from unitarity that the contribution from inelastic processes is governed by the overlap function $G(\rho, s)$, which in the u -matrix approach has the form [2]

$$G(\rho, s) = \frac{\Im u}{|1 - iu|^2},$$

or more explicitly - in case of the dipole pomeron (2):

$$G(\rho, s) = \frac{g(s)e^{-x}}{(1 + ge^{-x})^2},$$

where $x = \frac{\rho^2}{4\alpha'(b+L)}$.

Accordingly, the single diffraction dissociation cross section is

$$\sigma_{SD}(\rho, s) = \int \sigma_{SD}(\rho, s) d^2\rho = c4\pi\alpha'(b+L)\frac{\sqrt{g}}{(1+g)} = cg^{-1/2}\sigma_{in}(s).$$

The free parameter c can be eliminated by taking the ratio of the cross sections at two different energies:

$$\sigma_{SD}(s_2) = \sigma_{SD}(s_1)\frac{\sigma_{in}(s_2)}{\sigma_{in}(s_1)}\left(\frac{s_1}{s_2}\right)^{\epsilon/2}.$$

By using the values $\sigma_{SD}(\sqrt{s} = 53 \text{ GeV}) = 7.3 \pm 0.4 \text{ mb}$, $\sigma_{in}(\sqrt{s} = 53 \text{ GeV}) = 31.29 \text{ mb}$ and $\sigma_{in}(\sqrt{s} = 546 \text{ GeV}) = 47.68 \text{ GeV}$, we find $\sigma_{SD}(\sqrt{s} = 546 \text{ GeV}) = 9.67 \pm 0.5 \text{ mb}$.

To conclude, the measurement of the single diffraction cross section at Fermilab supports the concep of a moderate rise of the hadronic cross sctions. The unitarized dipole pomeron model use in this paper is a typical representative of this class of models.

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